International Journal of Agricultural
Science and Research (IJASR)
ISSN (P): 2250-0057; ISSN (E): 2321-0087
Vol. 7, Issue 5, Oct 20 17, 365-374

TRANS STELLAR
•Journal Publications • Research Consultancy

RESPONSE OF DIFFERENT PACKAGING AND STORAGE TEMPERATURES ON QUALITY AND BIOACTIVE COMPOUNDS OF ARILS OF POMEGRANATE CV. BHAGWA

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ABSTRACT

Studies were conducted to evaluate the stability of arils of pomegranate cv. Bhagwa in different packaging and storage temperatures. Arils packed in PPMM (P_3) recorded with high anthocyanin content (25.75 mg $100g^{-1}$) and β-carotene content (33.04 µg $100g^{-1}$), organoleptic score for colour (6.50), taste (6.25), flavour (6.17) and overall acceptability (6.08) with less microbial count (3.08 $\times10^8$CFU/ml) was observed. With respect to storage temperatures, arils stored at S_1(1°C) recorded high anthocyanin content (26.80 mg $100g^{-1}$) and β-carotene content (36.71 µg $100g^{-1}$) and organoleptic score for colour (7.33), taste (8.22), flavour (7.44) and overall acceptability (6.89) of arils was recorded at 1°C with lowest microbial count (1.89 $\times10^8$CFU/ml). The interaction effect of packing and storage temperatures, revealed that, high anthocyanin content (27.60 mg $100g^{-1}$) and β-carotene content (38.14 µg $100g^{-1}$), organoleptic score for aril colour (8.00), taste (8.67), flavour (7.67) and overall acceptability (7.67) with lowest microbial count (1.67 $\times10^8$CFU/ml) were recorded in P_3S_1.

KEYWORDS: Punica Granatum, Lansky & Newman

Received: Sep 04, 2017; **Accepted:** Sep 20, 2017; **Published:** Sep 27, 2017; **Paper Id.:** IJASROCT201743

Original Article

INTRODUCTION

Pomegranate (*Punica granatum* L.) can be considered as one of the most ideal crops, for the dry Deccan Plateau region of India. Its cultivation has become a highly remunerative agriculture business in India. It is a choicest fruit and is known for its chemo preventive and anti-inflammatory potential, due to its high antioxidant activity (Lansky & Newman, 2007) and it has exceptional and unique sensory and nutritional properties, such as proteins, carbohydrates, minerals, sugars and crude fibers (Marathe *et al*. 2010). Now days, due to its enormous health benefits against diabetes, intestinal and cardiovascular disorders dietary preference has been increased, rapidly. Pomegranate fruit and its juice are well known for its antioxidant property and hence becoming popular to prevent cancers of different tissues and organs. In addition to their nutritional composition and sensory attributes, foods are currently recognized as active and protective agents. For the food industry to meet these demands, creative product development, use of new processing and innovative food packaging technologies are needed to maintain product quality and safety as well as assures convenience to the consumer. Among all foods, fresh-cut or minimally processed horticultural produce such as apple, banana, mango, pineapple, watermelon and papaya (Arias *et al.*, 2007 ;) recognize as novel foods with innovative concepts that full fill the demand of modern lifestyle as

they provide convenience, fresh, safe, nutritious and healthy products. Additionally, pomegranate is one of the fruit which is minimally processed into fresh arils (Ayhan & Esturk, 2009; Martinezo-Romero *et al.*, 2013). In the last few years, there has been a rapid increase in the demand for industrial processing of pomegranate arils fresh consumption, processed products such as food colorants, tannins for leather, jellies, jams and wines (Caleb, Opara, & Witthuhn, 2012). Despite these beneficial properties, consumption of pomegranate fruit is not widespread, mainly due to the difficulties involved in removing the arils from fruit (Gil *et al*., 1996). This limitation promotes the need to process the fruit into minimally processed ready-to-eat arils (Artes *et al*., 1996; Gil *et al*., 1996). In modern society, the edible part of the pomegranate fruit is consumed as fresh arils or processed into fresh juice, canned as pastes and jam (Ersan *et al.*, 2010; Martinezo-Romero *et al.*, 2013) food colourants, inks, dyes and tannins for leather. With increasing demand for fresh and natural products without the addition of harmful chemicals, packaging film and storage temperature seems to be an ideal tool for preservation of arils. Selection of right packaging material and ideal temperature is very important for extending the shelf life of arils.

MATERIAL AND METHODS

The experiment was conducted at Post-Harvest Technology Laboratory, College of Horticulture (COH), Anantharajupet, YSR Kadapa district, Andhra Pradesh during the year, 2015. The fruits of pomegranate varieties, namely, Bhagwa used in the experiment were obtained from AICRP centre on Arid Zone fruits, Horticultural Research Station, Rekulakunta, Ananthapuramu district, Andhra Pradesh. The experiment was conducted in a completely randomized design replicated thrice with 3 packaging materials viz., PESP (P_1), PETP (P_2) and PPMM (P_3) and storage temperatures S_1 (1°C), S_2 (4°C), S_3 (8°C) and S_3 (room temperature). The following shelf life parameters were analyzed statistically and the results were presented.

Anthocyanin

The procedure outlined by Harborne (1973) was used for analyzing anthocyanin content (mg $100g^{-1}$), in pomegranate arils. One gram of pomegranate arils was macerated in one ml of methanol, containing one per cent hydrochloric acid. The content was kept overnight at a 0°C temperature in a deep freezer. The absorbance of the red colored solution was recorded at 530 nm on a spectrophotometer. Anthocyanin content was expressed as absorption units at 530 nm per gram fresh arils.

β-Carotene

The ß - carotene content of pomegranate arils was estimated by using the methodology of Srivastava and Kumar (2003). β-carotene was extracted from the sample, by crushing one gram of sample with 10 ml acetone and adding crystals of anhydrous sodium sulphate. The supernatant was decanted and collected in a beaker. The process was repeated twice. Ten ml of petroleum ether was added and mixed thoroughly. The content was transferred into a separating funnel and two layers were separated out on standing solution. Lower layer was discarded and upper layer was collected and the volume was made up to 20 ml with petroleum ether. The optical density was recorded at 452 nm using petroleum ether as blank.

Moulds and Yeast ($\times 10^8$CFU/ml)

For microbial count estimation, 28g of Nutrient Agar (NA) was suspended in a 1000 ml of distilled water in one beaker and 39g of Potato Dextrose Agar (PDA) in 1000 ml of distilled water in another beaker and both of them heated to

boiling in order to dissolve the medium completely. After that, sterilization was done by autoclaving at 15 lbs pressure (121°C) for 15 minutes. Mixed media were poured in Petri-plates in the laminar air flow chamber. The test tubes in the test tube stand were added with 9 ml distilled water in each test tube. After that, the test tubes were sterilized at 15 psi and 121°C in autoclave. One gram of aril juice was added in one test tube and labeled as 10. From this test tube, 1 ml of sample was taken to another test tube and labeled as 10^{-1}. This step is repeated up to 10^{-3}. 100 micro liter samples were taken and added aseptically with the help of micro pipette in three different NA and PDA plates and spread with the help of a spreader. These plates were kept in BOD incubator (PDA plates at 30°C and NA plates at 25°C) for incubation. Count for CFU was done after 48 hours.

Sensory Evaluation

The stored arils of pomegranate were examined for their sensory qualities by assessing the colour, flavour, texture and overall acceptability. Sensory evaluation was carried out by a panel of 5 judges and the rating was done with a score of 9 points Hedonic scale as proposed by Amerine *et al*. 1965.

Statistical Analysis

The data collected were analyzed statistically using factorial completely randomized design as per the procedure outlined by Pence and Sukhatme (1985) and valid conclusions were drawn only on significant differences between treatments mean at 0.05 per cent level of significance.

RESULTS AND DISCUSSIONS

Anthocyanin Content (mg $100g^{-1}$)

There were significant differences in anthocyanin (mg $100g^{-1}$) content of arils packed with different packing material and stored at different storage temperatures (Table 1). Among packing materials, arils packed in PPMM (P_3) recorded the highest anthocyanin content (mg $100g^{-1}$) (27.47, 27.08, 26.54 and 25.75) while, arils packed in PETP (P_2) recorded the lowest anthocyanin (mg $100g^{-1}$) content (26.25, 25.45, 24.98 and 24.39). The data recorded on anthocyanin content (mg $100g^{-1}$) revealed that higher values in arils stored at 1°C (S_1) (28.47, 27.81, 27.45 and 26.80) and lower values in arils stored at room temperature (S_4) (24.85, 24.19, 23.66 and 23.01). These results are in agreement with the findings of Artes *et al*. (2000) and Ayhan and Esturk (2009) in pomegranate cv. Hicaznar.

The interaction between packing material and storage temperatures had significant effect on anthocyanin content (mg $100g^{-1}$) of arils. Significantly the highest anthocyanin (mg $100g^{-1}$) content was recorded in PPMM + 1°C (P_3S_1) (29.19, 28.95, 28.62 and 27.60) and lowest anthocyanin content (mg $100g^{-1}$) in PETP + room temperature (P_2S_4) (24.24, 23.83, 23.15 and 22.54) on 4^{th}, 8^{th}, 12th ^{and} 16^{th} day of storage. A general trend of decrease in total anthocyanin content of arils was observed as the storage period advanced for all treatments. The decrease in anthocyanin content during storage might be due to oxidative activity of Polyphenol Oxidase (Vamos-Vigyazo, 1981).

β-Carotene Content (µg $100g^{-1}$)

It is observed from the data presented in Table 2 that, there was significant influence of packing material and storage temperatures on β-carotene content (µg $100g^{-1}$) of arils. The arils packed in PPMM (P_3) recorded significantly highest β-carotene content (µg $100g^{-1}$) (37.27, 36.00, 34.82 and 33.04) whereas, PETP (P_2) recorded the lowest beta-carotene content (µg $100g^{-1}$) 35.09, 34.28, 32.69 and 30.71 in Bhagwa, during the storage period. Maximum β-carotene

content (µg $100g^{-1}$) was observed in arils, stored at S_1(1°C) (28.50, 26.05, 24.20 and 21.91 and 39.91, 38.75, 38.31 and 36.71) while, minimum β-carotene content (µg $100g^{-1}$) was observed in arils stored at S_4 (room temperature) (30.22, 28.85, 25.99 and 22.09) Bhagwa cultivars.

In Bhagwa, the interaction effect was found significant on 4^{th}, 8^{th} and the 12th day of storage. High β-carotene content (µg $100g^{-1}$) was recorded in PPMM + 1°C (P_3S_1) (40.54, 39.30 and 38.97) while, low β-carotene content (µg $100g^{-1}$) was recorded on PETP + room temperature (P_2S_4) (28.15, 27.26 and 24.18). There were no significant differences observed on 16^{th} day of storage in arils of Bhagwa, with respect to β-carotene content. There was a reduction in β-carotene content of arils irrespective of packing, storage temperature and interaction effect, throughout the storage period as also reported by Pilon (2006) in Carrot and Green pepper. This may be due to high solubility of β-carotene content in water that favor large pigment loss, due to exposure of arils surface to water that is stored during the physiological process like respiration.

Moulds and Yeast (×10^8CFU/ml)

The data presented in Table 3 showed significant influences of packing material and storage temperatures on the growth of moulds and yeast on arils. The lowest microbial load (×10^8CFU/ml) was observed in arils packed in PPMM (P_3) (0.25, 0.92, 1.83 and 3.08) while, highest microbial load (×10^8CFU/ml) was recorded in PETP (P_2) (1.00, 2.08, 3.33 and 4.67). With regard to temperatures, no visual detection of mould growth was seen in S_1 (1°C) and S_2 (4°C) whereas, maximum microbial growth was observed at room temperature (S_4) (2.00) on the 4th day of storage. On the 8th day of storage, there was no visual mould growth seen at 1°C (S_1), while, minimum microbial count (×10^8CFU/ml) was observed on 8°C (S_3) (0.33) and maximum count (×10^8CFU/ml) in S_4 (room temperature) (3.44 Bhagwa). The lowest microbial load (×10^8CFU/ml) was observed at 1°C (S_1) (1.00 and 1.89) and highest microbial load (×10^8CFU/ml) was observed at room temperature (S_4) (5.00 and 7.78) during the 12th and 16th day of storage. The importance of storage temperature during storage of pomegranate arils have been emphasised by many researchers, who reported low temperatures (0-5°C) at modified atmosphere conditions was effective, to reduce respiration rate, enzymatic processes and microbial activity (Gil *et al.* 1996 b, Kader, 2002 and Nicola *et al*. 2009).

Significant differences were observed in the interaction effect between packing material and storage temperatures on microbial load (×10^8CFU/ml) of arils. On 4^{th}day of storage, there was no visual mould growth in P_1S_1, P_2S_1, P_3S_1, P_1S_2, P_2S_2, P_3S_2 and P_3S_2 whereas, maximum microbial load (×10^8CFU/ml) was observed in P_2S_4 (4.00). On the 8th day of storage, there was no visual mould growth in P_1S_1, P_2S_1, P_3S_1, P_1S_2 and P_3S_2 while, maximum microbial count (×10^8CFU/ml) was observed in P_2S_4 (4.67). On 12^{th} day, no significant difference was observed in the interaction effect of arils. On 16^{th} day, significant difference was observed in the interaction effect on microbial count (×10^8CFU/ml) of arils. Minimum microbial count (×10^8CFU/ml) was observed in PPMM + 1°C (P_3S_1) (1.67) and maximum in PETP + room temperature (P_2S_4)) (9.67). Gil *et al.* (1996), Kader (2002) and Nicola *et al*. (2009) reported that no visual detection of mould growth was seen in 'Arakta' and 'Bhagwa' arils stored at 1°C after 14 days. Higher storage temperature affected the proximate composition, physico-chemical attributes and bioactive components negatively. This study agrees with other researchers and advises pomegranate producers and retailers that the cold chain should be maintained at low (0-5°C) storage temperature and 95% RH for optimal quality of minimally processed arils of pomegranate. Soliva and Martin Belloso (2003) and Caleb *et al*. (2013) reported that, the physico-chemical properties of pomegranate arils, such as titratable acidity and cultivar have an important effect on microbial growth and shelf life of fresh cut arils. Gill *et al*. (1996)

used the lowest respiration rate as one of the measures to recommend 1°C, and Modular Mate pack for best quality preservation of pomegranate arils. Storage of arils under optimal MA has been shown to reduce the risk of enterobacteria and lactic acid bacteria as well as moulds and yeast counts (Sepulveda *et al*. 2000 and Lopez-Rubira *et al*. 2005 in pomegranate). Furthermore, since the pomegranate arils store at lower temperature, the risk of microbial proliferation was reduced. According to Artes *et al*. (2000a, b), higher levels of decay were mainly due to *Penicillium* spp. Similarly, Lopez-Rubira *et al*. (2005) observed a low count of micro-aerophilic lactic acid bacteria after 10 days of aril storage without any trace of fermentative metabolism.

Organoleptic Evaluation (9 Point Hedonic Scale)

Colour

There was a significant effect of packing material and storage temperatures on the sensory qualities of arils during the entire storage period (Table 5). Significantly the highest colour score was recorded in arils packed in PPMM (P_3) (7.83, 7.58, 7.33 and 6.50) and lowest colour score was recorded in arils packed in PETP (P_2) (7.00, 6.83, 5.75 and 5.25) during the storage period of 16 days. In case of storage temperatures, maximum colour score was recorded in arils stored at 1°C (S_1) (8.44, 8.33, 7.78 and 7.33) and minimum colour score was recorded in arils stored at room temperature (S_4) (6.00, 4.78, 3.89 and 3.00). There were no significant differences observed on the interaction effects of sensory attributes of arils packed with different packing material and storage temperatures throughout the storage period of sixteen days. Similar observation to this finding was also reported by Nanda *et al*. (2001) in pomegranate when fruits were packed in shrink film.

Taste

The taste of arils differed significantly with respect to packing material and storage temperatures (Table 6). The best rating for aril taste was recorded in PPMM (P_3). The maximum rating for aril taste was observed in P_3 (6.67, 6.50, 6.33 and 6.25) and minimum in PETP (P_2) (6.17, 6.08, 5.83 and 5.75) during the storage period of sixteen days. The highest score for aril taste was recorded at 1°C (S_1) (9.00, 9.00, 8.56 and 8.22) whereas, the lowest score for aril taste was recorded at room temperature (S_3) (8.11, 7.56, 7.56 and 7.22). There were no significant differences observed on the interaction effects of sensory attributes of arils packed with different packing material and storage temperatures throughout the storage period of sixteen days. During the storage period, there was a decreasing trend in organoleptic score, for taste of arils of Bhagwa due to fluctuations in acids, pH and sugar/acid ratio as reported by Malundo *et al*. (1991) in mango.

Flavour

Flavour of the arils packed with different packing materials and stored at different storage temperatures was found to be significant (Table 7). The minimum flavour score was observed in PPMM (P_3) (7.33, 6.83, 6.17 and 6.17) whereas, maximum of flavour score was observed in PETP (P_2) (6.50, 6.17, 5.50 and 5.50). Concerned to different temperatures, the lowest off flavour score was observed at 1°C (S_1) (8.00, 7.67, 7.44 and 7.44) while, highest off flavour score was observed at room temperature (S_4) (5.11, 4.22, 3.11 and 3.11). There were no significant differences observed on the interaction effects of sensory attributes of arils packed with different packing material and storage temperatures throughout the storage period of sixteen days. The maximum score for good flavour of arils appeared to be due to reduced rate of respiration and moisture loss from the arils and also less microbial contamination in the packing materials reported by Nanda *et al*. (2001) in pomegranate.

Overall Acceptability

It is evident from the data presented in Table 7 that the overall acceptability of arils varied significantly and the results were found significant. The highest overall acceptability of arils was recorded in PPMM (P_3) (7.58, 7.42, 7.08 and 6.08) and lowest overall acceptability of arils was recorded in PETP (P_2) (6.67, 6.17, 6.00 and 4.58) in Bhagwa cultivar during the storage period. With respect to storage temperatures, the maximum overall acceptability score of arils was recorded at 1°C (S_1) (8.56, 8.11, 7.44 and 6.89) and the minimum overall acceptability score was observed at room temperature (S_4) (4.22, 4.00, 4.00 and 2.00). The better the organoleptic score for pomegranate arils stored in Modular Mate at lower temperatures could be attributed to the maximum retention of chemical constituents in proper proportions. Similar observations were reported by Nanda *et al*. (2001) in pomegranate and Rathod *et al*. (2011) in carambola fruits. The interaction effects of packing material and a storage temperature on the sensory attributes of arils of Bhagwa cultivar was non-significant throughout the storage period. Maintaining the nutritional and organoleptic quality of pomegranate arils is a major challenge, because extracted arils deteriorate in colour, taste, flavour and overall acceptability and a reduction in shelf-life (Gil *et al*. 1996b). This is due to active metabolic processes by endogenous enzymatic activity and enhanced respiration rate as opined by Rolle and Chism (1987) in fruits and vegetables and Ergun and Ergun (2009) in Pomegranate.

CONCLUSIONS

Based on the results obtained from the study, it is concluded that, arils of pomegranate cv. Bhagwa packed in polypropylene modular mate (PPMM) and stored at temperature of 1°C retained appreciable nutritional, bio-active compound levels and other quality attributes such as aril colour, taste, flavour and overall acceptability at the end of storage period of sixteen days.

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APPENDICES

Table 1: Anthocyanin Content (mg 100g^{-1}) of Arils of Pomegranate cv. Bhagwa as Influenced by Different Packing Material and Storage Temperatures

Anthocyanin Content (mg 100g^{-1})																	
Storage Period (Days)																	
	0	4				8				12				16			
		P_1	P_2	P_3	Mean	P_1	P_2	P_3	Mean	P_1	P_2	P_3	Mean	P_1	P_2	P_3	Mean
S_1	31.51	28.07	28.14	29.19	28.47	27.83	26.65	28.95	27.81	27.49	26.24	28.62	27.45	27.05	25.76	27.60	26.80
S_2	31.51	27.83	26.92	28.00	27.59	27.43	26.00	27.90	27.11	26.99	25.83	27.66	26.83	26.07	25.46	27.22	26.25
S_3	31.51	25.87	25.70	27.39	26.32	25.63	25.32	26.82	25.92	25.29	24.71	25.83	25.28	24.41	23.79	24.81	24.34
S_4	31.51	25.02	24.24	25.29	24.85	24.10	23.83	24.64	24.19	23.79	23.15	24.03	23.66	23.15	22.54	23.35	23.01
Mean	31.51	26.70	26.25	27.47		26.25	25.45	27.08		25.89	24.98	26.54		25.17	24.39	25.75	
Statistics		S. Em±		CD@P=0.05		S. Em±		CD@P=0.05		S. Em±		CD@P=0.05		S. Em±		CD@P=0.05	
P		0.039		0.113		0.033		0.096		0.034		0.098		0.044		0.128	
S		0.045		0.130		0.038		0.111		0.039		0.113		0.051		0.148	
P×S		0.077		0.225		0.066		0.192		0.067		0.196		0.088		0.256	

Table 2: Effect of Different Packing Material and Storage Temperatures on β-Carotene Content (μg 100 g^{-1}) of Arils of Pomegranate cv. Bhagwa

β-Carotene Content (μg 100 g^{-1})																	
Storage Period (Days)																	
	0	4				8				12				16			
		P_1	P_2	P_3	Mean	P_1	P_2	P_3	Mean	P_1	P_2	P_3	Mean	P_1	P_2	P_3	Mean
S_1	42.20	40.29	38.89	40.54	39.91	39.05	37.89	39.30	38.75	38.72	37.23	38.97	38.31	36.40	35.58	38.14	36.71
S_2	42.20	39.47	38.14	39.88	39.16	37.98	37.40	38.89	38.09	37.48	36.49	38.23	37.40	35.66	34.75	36.24	35.55
S_3	42.20	36.07	35.16	36.49	35.91	35.25	34.58	35.83	35.22	33.51	32.85	34.42	33.59	32.85	32.43	33.43	32.90
S_4	42.20	30.33	28.15	32.17	30.22	29.28	27.26	30.00	28.85	26.13	24.18	27.67	25.99	21.84	20.08	24.33	22.09
Mean	42.20	36.54	35.09	37.27		35.39	34.28	36.00		33.96	32.69	34.82		31.69	30.71	33.04	
Statistics		S. Em±		CD@P=0.05		S. Em±		CD@P=0.05		S. Em±		CD@P=0.05		S. Em±		CD@P=0.05	
P		0.09		0.26		0.08		0.23		0.11		0.33		0.18		0.53	
S		0.10		0.30		0.09		0.26		0.13		0.38		0.21		0.61	
P×S		0.18		0.52		0.16		0.46		0.22		0.65		0.36		NS	

Table 3: Effect of Different Packing Material and Storage Temperatures on Microbial Count (×10^{8}CFU/ml) of Arils of Pomegranate cv. Bhagwa

Microbial Count (×10^{8}CFU/ml)																	
Storage Period (Days)																	
	0	4				8				12				16			
		P_1	P_2	P_3	Mean	P_1	P_2	P_3	Mean	P_1	P_2	P_3	Mean	P_1	P_2	P_3	Mean
S_1	0.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	1.33	0.67	1.00	2.00	2.00	1.67	1.89
S_2	0.0	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.33	1.67	2.33	1.33	1.78	2.33	3.00	2.00	2.44
S_3	0.0	0.33	0.67	0.00	0.33	1.67	2.67	1.33	1.89	2.00	3.67	1.67	2.44	2.67	4.00	2.33	3.00
S_4	0.0	1.33	4.00	0.67	2.00	3.33	4.67	2.33	3.44	5.33	6.00	3.67	5.00	7.33	9.67	6.33	7.78
Mean	0.0	0.42	1.17	0.17		1.25	2.08	0.92		2.50	3.33	1.83		3.58	4.67	3.08	
Statistics		S. Em±		CD@P=0.05		S. Em±		CD@P=0.05		S. Em±		CD@P=0.05		S. Em±		CD@P=0.05	
P		0.10		0.28		0.14		0.42		0.17		0.49		0.17		0.51	
S		0.11		0.32		0.17		0.49		0.19		0.56		0.20		0.58	
P×S		0.19		0.56		0.29		0.84		0.33		NS		0.35		1.01	

Table 4: Aril Colour of Pomegranate cv. Bhagwa as Influenced by Different Packing Material and Storage Temperatures

Aril Color (Organoleptic Score)																	
Storage Period (Days)																	
	0	4				8				12				16			
		P_1	P_2	P_3	Mean	P_1	P_2	P_3	Mean	P_1	P_2	P_3	Mean	P_1	P_2	P_3	Mean
S_1	9.00	8.67	8.00	8.67	8.44	8.33	8.00	8.67	8.33	8.00	7.00	8.33	7.78	7.67	6.67	8.00	7.33
S_2	9.00	8.33	7.67	8.33	8.11	8.00	8.00	8.00	8.00	7.67	7.00	8.00	7.56	7.33	6.33	7.67	7.11
S_3	9.00	7.67	7.67	7.67	7.67	7.67	7.33	8.00	7.67	7.33	6.33	7.67	7.11	6.33	6.33	6.67	6.44
S_4	9.00	6.67	4.67	6.67	6.00	4.67	4.00	5.67	4.78	3.67	2.67	5.33	3.89	3.33	1.67	4.00	3.00
Mean	9.00	7.83	7.00	7.83		7.17	6.83	7.58		6.67	5.75	7.33		6.17	5.25	6.50	
Statistics		S. Em±		CD@P=0.05		S. Em±		CD@P=0.05		S. Em±		CD@P=0.05		S. Em±		CD@P=0.05	
P		0.16		0.47		0.12		0.34		0.14		0.40		0.15		0.44	
S		0.18		0.54		0.14		0.40		0.16		0.46		0.18		0.51	
P×S		0.32		NS		0.24		NS		0.27		NS		0.30		NS	

Table 5: Taste of Arils of Pomegranate cv. Bhagwa as Influenced by Different Packing Material and Storage Temperatures

Taste (Organoleptic Score)																	
Storage Period (Days)																	
	0	4				8				12				16			
		P_1	P_2	P_3	Mean	P_1	P_2	P_3	Mean	P_1	P_2	P_3	Mean	P_1	P_2	P_3	Mean
S_1	9.00	9.00	8.67	9.33	9.00	9.00	8.67	9.33	9.00	8.67	8.00	9.00	8.56	8.00	8.00	8.67	8.22
S_2	9.00	8.67	8.00	9.00	8.56	8.33	8.00	8.67	8.33	8.00	8.00	8.33	8.11	8.00	8.00	8.33	8.11
S_3	9.00	8.00	8.00	8.33	8.11	8.00	7.67	8.00	7.89	7.33	7.33	8.00	7.56	7.33	7.00	8.00	7.44
S_4	9.00	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*
Mean	9.00	6.42	6.17	6.67		6.33	6.08	6.50		6.00	5.83	6.33		5.83	5.75	6.25	
Statistics		S. Em±		CD@P=0.05		S. Em±		CD@P=0.05		S. Em±		CD@P=0.05		S. Em±		CD@P=0.05	
P		0.10		0.28		0.11		0.31		0.10		0.28		0.08		0.24	
S		0.11		0.32		0.12		0.36		0.11		0.32		0.10		0.28	
P×S		0.19		NS		0.22		NS		0.19		NS		0.17		NS	

Table 6: Effect of Different Packing Material and Storage Temperatures on Flavour of Arils of Pomegranate cv. Bhagwa

Flavour of Arils (Organoleptic Score)																	
Storage Period (Days)																	
	0	4				8				12				16			
		P_1	P_2	P_3	Mean	P_1	P_2	P_3	Mean	P_1	P_2	P_3	Mean	P_1	P_2	P_3	Mean
S_1	9.00	8.00	7.67	8.33	8.00	7.67	7.33	8.00	7.67	7.67	7.00	7.67	7.44	7.67	7.00	7.67	7.44
S_2	9.00	7.67	7.00	8.00	7.56	7.67	6.67	7.67	7.33	7.00	6.33	7.00	6.78	7.00	6.33	7.00	6.78
S_3	9.00	7.67	6.67	7.67	7.33	7.00	6.67	7.00	6.89	6.67	6.00	6.67	6.44	6.67	6.00	6.67	6.44
S_4	9.00	5.33	4.67	5.33	5.11	4.00	4.00	4.67	4.22	3.33	2.67	3.33	3.11	3.33	2.67	3.33	3.11
Mean	9.00	7.17	6.50	7.33		6.58	6.17	6.83		6.17	5.50	6.17		6.17	5.50	6.17	
Statistics		S. Em±		CD@P=0.05		S. Em±		CD@P=0.05		S. Em±		CD@P=0.05		S. Em±		CD@P=0.05	
P		0.14		0.42		0.13		0.37		0.14		0.40		0.14		0.40	
S		0.17		0.49		0.15		0.43		0.16		0.46		0.16		0.46	
P×S		0.29		NS		0.25		NS		0.27		NS		0.27		NS	

Table 7: Effect of Different Packing Material and Storage Temperatures on Overall Acceptability of Arils of Pomegranate cv. Bhagwa

Overall Acceptability of Arils (Organoleptic Score)																	
Storage Period (Days)																	
	0	4				8				12				16			
		P_1	P_2	P_3	Mean	P_1	P_2	P_3	Mean	P_1	P_2	P_3	Mean	P_1	P_2	P_3	Mean
S_1	9.00	8.67	8.33	8.67	8.56	8.00	7.67	8.67	8.11	7.33	7.00	8.00	7.44	7.00	6.00	7.67	6.89
S_2	9.00	8.67	8.00	8.67	8.44	8.00	7.67	8.33	8.00	7.00	7.00	8.00	7.33	6.67	5.67	7.00	6.44
S_3	9.00	7.67	7.33	8.00	7.67	7.33	6.67	8.00	7.33	6.33	6.33	7.00	6.56	6.00	5.67	6.67	6.11
S_4	9.00	4.67	3.00	5.00	4.22	4.67	2.67	4.67	4.00	3.67	3.67	5.33	4.00	2.00	1.00	3.00	2.00
Mean	9.00	7.42	6.67	7.58		7.00	6.17	7.42		6.08	6.00	7.08		5.42	4.58	6.08	
Statistics		S. Em±		CD@P=0.05		S. Em±		CD@P=0.05		S. Em±		CD@P=0.05		S. Em±		CD@P=0.05	
P		0.14		0.40		0.14		0.42		0.12		0.34		0.11		0.31	
S		0.16		0.46		0.17		0.49		0.14		0.40		0.12		0.36	
P×S		0.27		NS		0.29		NS		0.24		NS		0.22		NS	

Table 8

P_1	-	PESP	S_1	-	1°C	P	-	Packing material
P_2	-	PETP	S_2	-	4°C	S	-	Storage temperature
P_3	-	PPMM	S_3	-	8°C	P×S	-	Interaction between packing material and storage temperature
			S_4	-	Room temperature	*	-	Decayed arils